LISTING OF CLAIMS

This Listing of Claims replaces all prior versions and listings of claims in this application.

1. (Currently amended) A signal processing apparatus ~~(400;800)~~ comprising:

a demodulator ~~(407;900)~~ arranged to demodulate a received signal, which carries consecutive symbols ~~(a_1,..., a_4)~~ at a symbol rate, wherein the demodulator ~~(407;900)~~ is arranged, based on sample values of the received signal, to calculate an error value [[(ϕ_m)]] of a given symbol relative to a decision-directed determination of an expected symbol value [[($\hat{\theta}$)]]; and

a phase-shifter ~~(406,409;801;1002,1013)~~ arranged to shift [[the]] a phase of sampling points in time at which points in time, sample values of the received signal [[is]] are provided to the demodulator ~~(407;1000)~~; and

~~CHARACTERIZED IN THAT the apparatus (400;900) comprises~~

a processor ~~(408;601;1000)~~ arranged to evaluate an error metric [[(τ)]], at the symbol rate, for a given symbol as a function of the error value [[(ϕ)]] and symbol values [[($\hat{\theta}$;θ)]], and to determine whether to shift the phase of the sampling points in time based on further evaluation of the error metric [[(τ)]].

2. (Currently amended) A signal processing apparatus according to claim 1, ~~CHARACTERIZED IN THAT~~ wherein the error metric [[(τ)]] is a function of symbol values [[($\hat{\theta}_{m-1}$;$\hat{\theta}_{m+1}$;θ_{m-1};θ_{m+1})]] for symbols preceding and succeeding the given symbol [[(m)]].

3. (Currently amended) A signal processing apparatus according to claim 1 ~~or 2,~~ ~~CHARACTERIZED IN THAT~~, wherein the error metric [[(τ)]] is a function of expected symbol values [[$\hat{\theta}$]].

4. (Currently amended) A signal processing apparatus according to ~~any of claims 1-3, CHARACTERIZED IN THAT~~ claim 1, wherein the demodulator ~~(407;900)~~ is configured as a Phase Shift Keying (PSK) demodulator or a Differential Phase Shift Keying (DPSK) demodulator.

5. (Currently amended) A signal processing apparatus according to ~~any of claims 1-4, CHARACTERIZED IN THAT~~ claim 1, wherein the error metric [[(τ)]] is a function of the phase error value [[(ϕ_m)]] of a given symbol relative to the decision-directed determination of an expected symbol phase value [[($\hat{\theta}_m$)]], the phase value of a previous symbol [[(θ_{m-1})]], and the phase of a succeeding symbol [[(θ_{m+1})]].

6. (Currently amended) A signal processing apparatus according to ~~any of claims 1-5, CHARACTERIZED IN THAT~~ claim 1, wherein the error metric [[(τ)]] is a function of the phase error [[(ϕ_m)]] of the received symbol [[(m)]] multiplied by [[the]] a difference between the phase [[(θ_{m-1})]] of a previous symbol [[(m−1)]] and the phase [[(θ_{m+1})]] of a succeeding symbol [[(m+1)]].

7. (Currently amended) A signal processing apparatus according to ~~any of claims 1-6, CHARACTERIZED IN THAT~~ claim 1, wherein the error metric ~~(τ) is composed of~~ includes a first term [[(τ^e_m),]] representing that the sampling phase is advanced in time and a second term [[(τ^l_m),]] representing that the sampling phase is delayed in time relative to an optimal sampling phase [[(τ)]].

8. (Currently amended) A signal processing apparatus according to ~~any of claims 1-7, CHARACTERIZED IN THAT~~ claim 7, wherein the first term [[(τ^e_m),]] is the phase error of the received symbol [[(m)]] multiplied by the phase [[(θ)]] of [[the]] a succeeding symbol [[(m+1)]], and the second term [[(τ^l_m)]] is the phase error [[(ϕ)]] of the received symbol [[(m)]] multiplied by the phase [[(ϕ)]] of [[the]] a preceding symbol [[(m−1)]].

9. (Currently amended) A signal processing apparatus according to ~~any of claims 1-8, CHARACTERIZED IN THAT~~ claim 1, wherein the demodulator ~~(407;900)~~ is arranged to calculate a variable [[(τ^{tt})]] for time tracking based on an accumulated sum of the error metric [[(τ)]].

10. (Currently amended) A signal processing apparatus according to ~~any of claims 1-9, CHARACTERIZED IN that~~ claim 9, wherein the processor ~~(408;601;1000)~~ is arranged to determine whether to shift the phase, based on the accumulated sum [[(τ^{tt})]] of the error metric.

11. (Currently amended) A signal processing apparatus according to ~~any of claims 1-10, CHARACTERIZED IN that~~ claim 1, wherein the error metric [[(τ)]] expresses Inter Symbol Interference based on an estimate, which is based on an estimated impulse response for a transmission channel [[(103)]] over which the symbol is transmitted prior to being input to the signal processing apparatus [[(800)]].

12. (Currently amended) A signal processing apparatus according to ~~any of claims 1-11, CHARACTERIZED IN THAT~~ claim 1, wherein the apparatus comprises a sampler ~~(405,404)~~ arranged to sample the signal at an over sampling ratio OSR, which provides OSR samples per symbol; and [[that]] the phase-shifter ~~(406,409)~~ is arranged to control which out of every N samples [[that]] is to be provided to the demodulator [[(107)]].

13. (Currently amended) A signal processing apparatus according to ~~any of claims 1-12, CHARACTERIZED IN THAT~~ claim 1, wherein the demodulator ~~(407;900)~~ is arranged to calculate the error value [[(ϕ_m)]] of a given symbol additionally, relative to a reference value ~~(ψ), wherein~~ and the reference value is calculated, based on a calculated error value [[(ϕ_{m-1})]] of previously received symbols.

14. (Currently amended) A mobile telephone ~~CHARACTERIZED IN~~ comprising a signal processing apparatus [[(800)]] as set forth in ~~any of the claims 1-13~~ claim 1.

15. (Currently amended) A method of processing a signal, comprising the steps of:

demodulating a received signal, which carries consecutive symbols ~~($a_1,\ldots, a_4$)~~ at a symbol rate, and

based on sample values of the received signal, ~~calculate~~ calculating an error value [[(ϕ_m)]] of a given symbol relative to a decision-directed determination of an expected symbol value [[($\hat{\theta}$)]]; and

shifting the phase of sampling points in time; and

~~CHARACTERIZED IN further comprising the step of~~

evaluating an error metric [[(τ)]], at the symbol rate, for a given symbol as a function of the error value [[(ϕ)]] and symbol values [[($\hat{\theta};\theta$)]], and

~~to determine~~ determining whether to shift the phase of the sampling points in time based on further evaluation of the error metric [[(τ)]].

16. (Currently amended) A method of processing a signal according to claim 15, ~~CHARACTERIZED IN THAT~~ wherein the error metric [[(τ)]] is a function of symbol values [[$(\hat{\theta}_{m-1};\hat{\theta}_{m+1};\theta_{m-1};\theta_{m+1})$]] for symbols preceding and succeeding the given symbol [[(m)]].

17. (Currently amended) A method of processing a signal according to claim 15 ~~or 16, CHARACTERIZED IN THAT~~, wherein the error metric [[(τ)]] is a function of expected symbol values [[$\hat{\theta}$]].

18. (Currently amended) A method of processing a signal according to ~~any of claims 15-17, CHARACTERIZED IN THAT~~ claim 15, wherein the demodulation is Phase Shift Keying (PSK) demodulation or Differential Phase Shift Keying (DPSK) demodulation.

19. (Currently amended) A method of processing a signal according to ~~any of claims 15-18, CHARACTERIZED IN THAT~~ claim 15, wherein the error metric [[(τ)]] is a function of the phase error value [[(ϕ_m),]] of a given symbol relative to the decision-directed determination of an expected symbol phase value [[$(\hat{\theta}_m)$]], the phase value of a previous symbol [[(θ_{m-1})]], and the phase of a succeeding symbol [[(θ_{m+1})]].

20. (Currently amended) A method of processing a signal according to ~~any of claims 15-19, CHARACTERIZED IN THAT~~ claim 15, wherein the error metric [[(τ)]] is a function of the phase error [[(ϕ_m)]] of the received symbol [[(m)]] multiplied by [[the]] a difference between the phase [[(θ_{m-1})]] of a previous symbol [[$(m-1)$]] and the phase [[(θ_{m+1})]] of a succeeding symbol [[$(m+1)$]].

21. (Currently amended) A method of processing a signal according to ~~any of claims 15-20, CHARACTERIZED IN THAT~~ claim 15, wherein the error metric ~~(τ) is composed of~~ includes a first term [[$(\tau^e{}_m)$]] representing that the sampling phase is advanced in time and a second term [[$(\tau^l{}_m)$]] representing that the sampling phase is delayed in time relative to an optimal sampling phase [[(τ)]].

22. (Currently amended) A method of processing a signal according to ~~any of claims 15-21, CHARACTERIZED IN THAT~~ claim 21, wherein the first term [[($\tau^e{}_m$)]] is the phase error [[(ϕ)]] of the received symbol [[(m)]] multiplied by the phase [[(θ)]] of the succeeding symbol [[(m+1)]], and the second term [[$\tau^l{}_m$]] is the phase error [[(ϕ)]] of the received symbol [[(m)]] multiplied by the phase [[(θ)]] of the preceding symbol [[(m−1)]].

23. (Currently amended) A method of processing a signal according to ~~any of claims 15-22, CHARACTERIZED IN THAT~~ claim 15, wherein the demodulation comprises calculation of a variable [[(τ^{tot})]] for time tracking based on an accumulated sum of the error metric [[(τ)]].

24. (Currently amended) A method of processing a signal according to ~~any of claims 15-23, CHARACTERIZED IN THAT~~ claim 23, wherein the evaluation comprises determination of whether to shift the phase, based on the ~~accumulated sum (τ^{tot}) of the error metric~~ variable for time tracking.

25. (Currently amended) A method of processing a signal according to ~~any of claims 15-24, CHARACTERIZED 1N THAT~~ claim 15, wherein the error metric [[(τ)]] expresses Inter Symbol Interference based on an estimate, which is based on an estimated impulse response for a transmission channel [[(103)]] over which the symbol is transmitted prior to being received.

26. (Currently amended) A method of processing a signal according to ~~any of claims 15-25, CHARACTERIZED IN~~ claim 15, further comprising the step of sampling the signal at an over sampling ratio OSR, which provides OSR samples per symbol; and [[that]] the step of shifting the phase involves controlling which out of every N samples [[that]] is to be provided for demodulation.

27. (Currently amended) A method of processing a signal according to ~~any of claims 15-26, CHARACTERIZED IN THAT~~ claim 15, wherein the demodulating includes calculating the error value of a given symbol relative to a reference value, and the reference value is calculated, based on a calculated error value [[(ϕ_{m-1})]] of previously received symbols.